PATENT APPLICATION

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re the application of: Attorney Docket No.: 3081.126US01

Peter Westphal et al. Confirmation No.: 8968

Application No.: 10/552,557 Examiner: Derek S. Chapel

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DECLARATION UNDER 37 C.F.R. 1.132

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

I, Paul Onderick, herein declare:

1. That the attached is a true and correct copy of excerpts from *Modern Cosmology* edited by S. Bonometto, V. Gorini and U. Moschella.

That further the declarant sayeth not.

Signed this 4th day of February, 2009.

Paul Onderick

Declaration prepared by
Paul C. Onderick
Registration No. 45,354

Patterson, Thuente, Skaar & Christensen, P.A.
4800 IDS Center
80 South 8th Street
Minneapolis, Minnesota 55402-2100
Telephone: (612) 349-5774

Exhibit A

INSTITUTE OF PHYSICS
SERIES IN HIGH ENERGY PHYSICS, COSMOLOGY AND GRAVITATION

MODERN COSMOLOGY

EDITED BY
S BONOMETTO
V GORINI
U MOSCHELLA

IoP

MODERN COSMOLOGY

Edited by

Silvio Bonometto

Department of Physics,
University of Milan—Bicocca, Milan

Vittorio Gorini and Ugo Moschella

Department of Chemical, Mathematical and Physical Sciences,
University of Insubria at Como

IoP

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The Schwarzschild radius for a body of mass M is given by

$$R_S = \frac{2GM}{c^2}, \tag{14.8}$$

thus the absolute value of the deflection angle can also be written as $\alpha = 2R_S/b$. For the Sun the Schwarzschild radius is 2.95 km, whereas its physical radius is 6.96×10^5 km. Therefore, a light ray which just grazes the solar surface is deflected by an angle corresponding to $1.7''$.

14.2.2 Thin lens approximation

From these considerations one sees that the main contribution to the light deflection comes from the region $\Delta z \sim \pm b$ around the lens. Typically, Δz is much smaller than the distance between the observer and the lens and the lens and the source, respectively. The lens can thus be assumed to be thin compared to the full length of the light trajectory. Thus one considers the mass of the lens, for instance a galaxy cluster, projected onto a plane perpendicular to the line of sight (between the observer and the lens) and going through the centre of the lens. This plane is usually referred to as the lens plane and, similarly, one can define the source plane. The projection of the lens mass on the lens plane is obtained by integrating the mass density ρ along the direction perpendicular to the lens plane:

$$\Sigma(\boldsymbol{\xi}) = \int \rho(\boldsymbol{\xi}, z)\, \mathrm{d}z, \tag{14.9}$$

where $\boldsymbol{\xi}$ is a two-dimensional vector in the lens plane and z is the distance from the plane. The deflection angle at the point $\boldsymbol{\xi}$ is then given by summing over the deflection due to all mass elements in the plane as follows.

$$\boldsymbol{\alpha} = \frac{4G}{c^2} \int \frac{(\boldsymbol{\xi} - \boldsymbol{\xi}')\Sigma(\boldsymbol{\xi}')}{|\boldsymbol{\xi} - \boldsymbol{\xi}'|^2}\, \mathrm{d}^2\xi'. \tag{14.10}$$

In the general case the deflection angle is described by a two-dimensional vector. However, in the special case that the lens has circular symmetry one can reduce the problem to a one-dimensional situation. Then the deflection angle is a vector directed towards the centre of the symmetry with absolute value given by

$$\alpha = \frac{4GM(\xi)}{c^2\xi}, \tag{14.11}$$

where ξ is the distance from the centre of the lens and $M(\xi)$ is the total mass inside a radius ξ from the centre, defined as

$$M(\xi) = 2\pi \int_0^{\xi} \Sigma(\xi')\xi'\, \mathrm{d}\xi'. \tag{14.12}$$